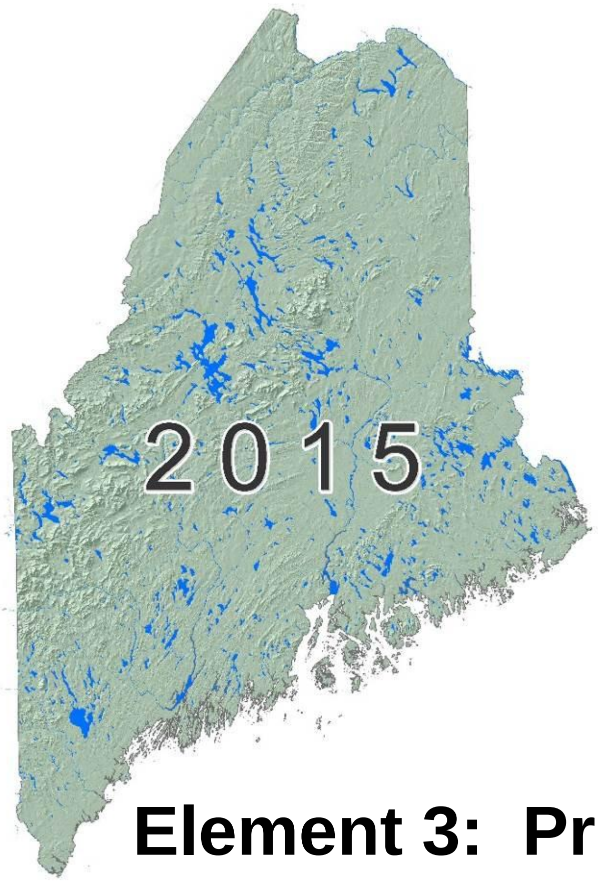


MAINE'S WILDLIFE ACTION PLAN

Element 3: Problems Affecting SGCN and Their Habitats

Prepared by

Maine Department of Inland Fisheries and Wildlife

In collaboration with

Maine's Conservation Partners

September 2015

TABLE OF CONTENTS

Element 3 – Problems Affecting SGCN and Their Habitats

3.0 Abstract.......... 1

3.1 Introduction.......... 2
- 3.1.1 Significant Differences from Maine's 2005 Plan.......... 2
- 3.1.2 Assigning Stressors – General Considerations.......... 3
- 3.1.3 Stressor Classification and Characteristics.......... 3
- 3.1.4 Assigning and Prioritizing Stressors for SGCN.......... 10
- 3.1.5 Assigning Stressors for Habitats.......... 10

3.2 Stressors to SGCN.......... 11

3.3 Stressorts to Habitats.......... 17

3.4 Literature Cited and References.......... 19

LIST OF TABLES

Table 3-1. Nomenclature, Descriptions, and Examples of Positive Impacts on Wildlife for IUCN Threat Categories assigned to SGCN and Habitats in Maine. 5

Table 3-2. Characteristics and rankings used to summarize stressors assigned to SGCN and Habitats. Adapted from Crisfield et al. 2013. 9

Table 3-3. IUCN Threat Category and the Number of Priority 1 SGCN, Priority 1 SGCN, and Habitat Macrogroups associated with each category. Complete stressor reports can be downloaded by clicking on the hyperlinks within the table. 12

Table 3-4. Secondary IUCN Threat Categories and the number of Priority 1 and Priority 2 SGCN assigned to each category where the stressor was ranked as either high or medium-high priority for action. Complete stressor reports can be downloaded by clicking on the hyperlinks within the table...15

LIST OF FIGURES

Figure 3-1. SGCN Stressor Priority Level based on Severity and Reversibility. 10

Figure 3-2. Number of SGCN stressor assignments categorized as low, medium, medium-high, and high priority. 14

KEY TO ACRONYMS

IUCN	International Union for the Conservation of Nature
MDIFW	Maine Department of Inland Fisheries and Wildlife
SGCN	Species of Greatest Conservation Need

3.0 ABSTRACT

Maine's State Wildlife Action Plan (SWAP) focuses much attention on the habitats used by Species of Greatest Conservation Need (SGCN). The Plan uses a coarse filter – fine filter approach to conservation to ensure that, where possible, individual conservation initiatives benefit multiple species, while also acknowledging that some species require individualized attention. We assigned stressors to both habitats and to SGCN, in order to clearly identify the issues that should be addressed at each level in the conservation hierarchy. As with most other states in the Northeast, we identified stressors using the International Union for the Conservation of Nature (IUCN) Threat Classification Scheme. While the IUCN system is useful for categorizing stressors to SGCN and their habitats, we found that the system lacks the resolution to clearly identify the specific issues that should be considered for conservation attention. Therefore, when assigning stressors we chose to adopt the primary and secondary IUCN categories, but replaced the tertiary category with a detailed narrative that fully describes the issue and its impact on the species or habitat being considered. In addition, we adapted Table 7 (*Threat characteristics and categorical ratings)* from The Northeast Lexicon to identify characteristics for each stressor assignment.

We assigned stressors to Priority 1 and 2 SGCN, and assigned 'Severity' and 'Actionabilty' characteristics for each Stressor – SGCN interaction. We implicitly considered the concepts of 'Likelihood', 'Certainty' and 'Spatial Extent', and assigned only those stressors that were determined to have a moderate or high Impact for each of these characteristics. In addition, only those stressors with moderate or high Severity were assigned to SGCN. We developed a simple matrix to prioritize SGCN stressors, using the combination of the Impact scores for 'Severity' and 'Actionability.' We identified stressors for terrestrial and freshwater aquatic habitats using Anderson et al. (2013) as our primary reference. Because no single comprehensive source is available that describes that state of marine habitats along Maine's coast, we used a wide variety of scientific publications, as well as expert opinion of agency staff and partners, to compile information on stressors. We assumed that the habitat systems within each terrestrial and marine macrogroup all faced similar conservation problems; therefore we assigned stressors to each macrogroup, but did not identify stressors separately for each habitat system, with the exception of freshwater aquatic habitats (River and Streams, and Lakes and Ponds) were we identified stressors separately for each of systems Unlike our approach for SGCN, we assigned all seven stressor characteristics for each habitat – stressor combination.

We assigned 38 unique stressors to 190 Priority 1 and 2 SGCN species, for a total of 1,099 SGCN – stressor combinations, and 31 unique stressors to 34 habitats macrogroups, for a total of 326 habitat – stressor combinations. Development, including existing and new Roads and Railroads and Housing and Urban Areas, and Invasive Non-native/Alien Species/Diseases, impacted largest number of habitats.

3.1 INTRODUCTION

In previous elements, we summarized what we know about the abundance and distribution of Maine's fauna, described how we selected SGCN, and described how we identified and characterized Maine's key habitats. In this element, we outline how we integrated this information with information on problems facing SGCN and their habitats.

The problems that impact SGCN are often multi-faceted, with a variety of ultimate and proximate causes that lead to negative impacts on a species' habitat, behavior, or health. In some cases, issues that have negative impacts for some species, such as a particular type of agriculture, may be highly beneficial to other species. Therefore, the factors that impact SGCN must be considered thoughtfully, with recognition that measures designed to resolve problems faced by one species may have negative implications for others. This is especially important in Maine, where much of the state is privately owned and managed for the production of forestry or agricultural products; invariably these activities are less impactful on SGCN than alternate land uses, such as commercial development. Nonetheless, identifying problems for SGCN and their habitats is a fundamental step towards developing meaningful Conservation Actions that will have the greatest benefit for the full suite of SGCN that are present in Maine.

> *"The factors that impact SGCN must be considered with the understanding that measures designed to resolve problems faced by one species may have negative implications for others"*

3.1.1 SIGNIFICANT DIFFERENCES FROM MAINE'S 2005 PLAN

In 2005, the Maine Department of Inland Fisheries and Wildlife used a variety of international, national, regional, and state plans and initiatives to compile information on the problems impacting SGCN and their habitats. Efforts focused on Priority 1 and Priority 2 species, with some attention given to Priority 3 species in certain taxonomic groups. The plan identified the major known stressors to each SGCN, with recognition that additional stressors existed that were poorly understood or were of relatively low priority. The information was descriptive, and did not follow a standardized approach for stressor categorization or nomenclature.

In this plan, we made several revisions to our approach for identifying problems for SGCN and their habitats, including:

- Replaced the term 'threat' with 'stressor' to acknowledge that factors that are a problem for some SGCN may be beneficial for others. We continue to use the term 'threat' only when referring to the IUCN classification scheme (see below).
- In addition to identifying stressors for habitats, we identified stressors for Priority 1 and Priority 2 SGCN, but not Priority 3 species.
- Utilized the IUCN Threat Classification Scheme to categorize stressors.
- Used an adapted version of Table 7 (*Threat characteristics and categorical ratings)* from The Northeast Lexicon to identify characteristics for each stressor assignment.
- Categorized SGCN stressors as either Low, Medium, Medium-High, or High priority for Action.

3.1.2 ASSIGNING STRESSORS – GENERAL CONSIDERATIONS

Although Maine's Wildlife Action Plan is ultimately intended to benefit SGCN, our plan focuses much attention on the habitats used by these species. This coarse filter – fine filter approach to conservation ensures that, where possible, individual conservation initiatives benefit multiple species, while also acknowledging that some species require individualized attention. In keeping with this approach, we assigned stressors to both habitats and to SGCN, in order to clearly identify the issues that should be addressed at each level in the conservation hierarchy. We assumed that the stressors identified for habitats would apply to the SGCN that used those habitats, reducing or eliminating the need to assign these same stressors to individual SGCN. To advance our goal of developing a highly prioritized, streamlined Action Plan, we used a strategic approach to identify stressors to SGCN that included assignment of only those stressors that are currently having, or in the near future are likely to have, a significant impact on high priority SGCN (see section 3.1.4 for further detail).

"A coarse filter – fine filter approach to conservation ensures that where possible, individual conservation initiatives benefit multiple species, while also acknowledging that some species require individualized attention"

To identify stressors specific to SGCN and their habitats, we consulted international, national, regional, and state plans and initiatives, including Maine's 2005 Comprehensive Wildlife Conservation Strategy (MDIFW 2005). We also consulted recent scientific literature and state surveys, particularly for marine species, which were not fully included in Maine's 2005 Plan. Our knowledge base of stressors was also supplemented from our comprehensive species planning process (Chapters 6, 7, MDIFW 2005). As part of the planning process, we developed species assessments for individual species or groups of species, which required the author (species expert) to identify known stressors to the species and their habitats. Other species experts reviewed these assessments and provided additional input, and following this review, a public working group further identified threats to the species and its habitats as they developed species management goals and objectives. We also relied on species experts within MDIFW and the Maine Dept. of Marine Resources, who through years of experience and accumulated knowledge have become very familiar with the stressors facing the species with which they work. Finally, we provided Conservation Partners the opportunity to critique these tables and provide further input. For more detailed information on sources we consulted, please refer to the *Literature Cited and References* section of this document.

Although we sought to identify the major, known stressors to each SGCN and habitat, we know that there may be stressors that we did not list. Also, our knowledge of some species is very limited, and consequently we may not clearly understand the stressors they face.

3.1.3 STRESSOR CLASSIFICATION AND CHARACTERISTICS

As did most other states in the Northeast, we identified stressors using the IUCN Threat Classification Scheme (http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme). The IUCN developed this classification scheme to provide conservationists with a universal menu of terminology to describe the "proximate human activities or processes that have impacted, are impacting, or may impact the status of the taxon being assessed" (IUCN 2015). The IUCN classification scheme is hierarchical, and includes 11 primary (Level 1) threat categories, 44 secondary (Level 2) categories, and 76 tertiary (Level 3) categories. The categories are customizable, and may be expanded at each level in the hierarchy if necessary to adequately describe the impact being assessed. Although some categories are not applicable to Maine (e.g. earthquakes, volcanoes), our assessment of the IUCN hierarchy determined that the classification system included most factors that negatively impact SGCN in our state. Most stressors are recognized as having potentially negative and positive impacts on different wildlife species. Table 3-1 contains a list of the IUCN Level 2 threat categories that were determined to negatively impact SGCN and their habitats in Maine, a brief description of those stressors, and where applicable, examples of positive impacts that the stressor may have for other wildlife.

Improperly installed culverts can impede movement and restrict habitat connectivity for many aquatic ecosystems. In this case, a fish ladder may allow some species to traverse the barrier. © Department of Marine Resources

While the IUCN system is useful for categorizing stressors to SGCN and their habitats, and will ultimately allow multi-state summaries of these factors across the Northeast region, we found that the system lacks the resolution to clearly identify the specific issues that should be considered for conservation attention. Therefore, when assigning stressors we chose to adopt the primary and secondary IUCN categories (e.g. the first and second levels of the hierarchy), but replaced the tertiary category with a detailed narrative that describes the issue and its impact on the species or habitat being considered. This approach provided more detailed information on the stressor than the IUCN system allows, which we ultimately found important when considering whether stressors should be addressed with conservation actions. In addition, it should be noted that for some stressor categories, particularly those associated with natural resource use (such as aquaculture, wood harvesting, and fishing), it is not the presence of the activity itself that necessarily causes stress, but rather the way in which it is practiced. Although we use the standard IUCN terminology to describe these stressors, the narrative for each SGCN or habitat stressor contains more detail on the actual practice being considered.

Roads can fragment habitat and contribute to mortality for many turtles and other SGCN. © Department of Inland Fisheries and Wildlife

In addition to identifying stressors using a modified version of the IUCN system, we adapted Table 7 (*Threat characteristics and categorical ratings)* from The Northeast Lexicon to identify characteristics for each stressor assignment (Crisfield et al. 2013). This table presents six Threat Characteristics that biologists used to describe the specific nature of a particular stressor: 'Severity', 'Reversibility', 'Immediacy', 'Spatial Extent', 'Certainty', and 'Likelihood'. Each characteristic can be identified as having a low, moderate, or high level of impact (Table 3-2).

Table 3-1. Nomenclature, Descriptions, and Examples of Positive Impacts on Wildlife for IUCN Threat Categories assigned to SGCN and Habitats in Maine.

IUCN Threat Category	Description	Example of Positive Impact on Wildlife
Residential and Commercial Development		
Housing and Urban Areas	Human cities, towns, and settlements including non-housing development typically integrated with housing	Some species are adept at utilizing human-food sources and habitats provided in residential areas
Commercial and Industrial Areas	Factories and other commercial centers	Large commercial buildings may provide nesting habitat for some species (e.g. Peregrine Falcons)
Tourism and Recreational Areas	Tourism and recreation sites with a substantial footprint	These areas often enhance the public's perceptions of wildlife and the outdoors, which is important to building support for conservation
Agriculture and Aquaculture		
Annual and Perennial Non-timber crops	Crops planted for food, fodder, fiber, fuel, or other uses	Provides forage for a wide variety of wildlife species
Livestock Farming and Ranching	Domestic terrestrial animals raised in one location on farmed or non-local resources (farming); also domestic or semi-domesticated animals allowed to roam in the wild and supported by natural habitats (ranching)	Maintains grassland habitat required by many wildlife species
Marine and Freshwater Aquaculture	Aquatic animals raised in one location on farmed or non-local resources; also hatchery fish allowed to roam in the wild	Reduces reliance on wild-caught fish for human consumption
Energy Production and Mining		
Oil and Gas Drilling	Exploring for, developing, and producing petroleum and other liquid hydrocarbons	
Mining and Quarrying	Exploring for, developing, and producing minerals and rocks	
Renewable Energy	Exploring, developing, and producing renewable energy	Reduces reliance on non-renewable energy sources
Transportation and Service Corridors		
Roads and Railroads	Surface transport on roadways and dedicated tracks	

Table 3-1. *continued: page 2 of 4.*

IUCN Threat Category	Description	Example of Positive Impact on Wildlife
Transportation and Service Corridors - *continued*		
Utility and Service Lines	Transport of energy & resources	Provides early successional habitat important for some wildlife (e.g. New England Cottontail)
Shipping Lanes	Transport on and in freshwater and ocean waterways	
Biological Resource Use		
Hunting and Collecting Terrestrial Animals	Killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch	Important wildlife management tool to help prevent overabundant wildlife populations
Gathering Terrestrial Plants	Harvesting plants, fungi, and other non-timber/non-animal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons	Can increase society's connection with wildlife, often leading to increased support for conservation
Logging and Wood Harvesting	Harvesting trees and other woody vegetation for timber, fiber, or fuel	Provides wildlife habitat for many species by altering forest structure and composition
Fishing and Harvesting of Aquatic Resources	Harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch	Can increase society's connection with wildlife, often leading to increased support for conservation
Human Intrusions and Disturbance		
Recreational Activities	People spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons	Improves society's connection with wildlife, often leading to increased support for conservation
War, Civil Unrest and Military Exercises	Actions by formal or paramilitary forces without a permanent footprint	
Work and Other Activities	People spending time in or traveling in natural environments for reasons other than recreation or military activities	

Table 3-1. *continued: page 3 of4.*

IUCN Threat Category	Description	Example of Positive Impact on Wildlife
Natural Systems Modifications		
Fire and Fire Suppression	Suppression or increase in fire frequency and/or intensity outside of its natural range of variation	Fire (both natural and prescribed) can enhance some wildlife habitats and is required for regeneration in some forest types
Dams and Water Management/Use	Changing water flow patterns from their natural range of variation either deliberately or as a result of other activities	Can be used to enhance habitat for fish and wildlife species (e.g. waterfowl) and to provide a renewable energy source.
Other Ecosystem Modifications	Other actions that convert or degrade habitat in service of "managing" natural systems to improve human welfare	
Invasive and Other Problematic Species, Genes and Diseases		
Invasive Non-native/Alien Species/Diseases	Harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities	
Problematic Native Species/Diseases	Harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question, but have become "out-of-balance" or "released" directly or indirectly due to human activities	
Problematic Species/Diseases of Unknown Origin	Harmful plants, animals, or pathogens and other microbes of unknown origin.	
Viral/Prion-induced Diseases	Viruses are small infectious agents that replicate only inside the living cells of an organism. Prions are infectious agents composed of protein in a misfolded form.	
Pollution		
Domestic and Urban Waste Water	Water-borne sewage and non-point runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments	

Table 3-1. *continued: page 4 of 4.*

IUCN Threat Category	Description	Example of Positive Impact on Wildlife
Pollution - *continued*		
Industrial and Military Effluents	Water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments	
Agricultural and Forestry Effluents	Water-borne pollutants from agricultural, silivicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied	
Garbage and Solid Waste	Rubbish and other solid materials including those that entangle wildlife	
Air-Bourne Pollutants	Atmospheric pollutants from point and nonpoint sources	
Excess Energy	Inputs of heat, sound, or light that disturb wildlife or ecosystems	
Climate Change and Severe Weather		
Habitat Shifting or Alteration	Major changes in habitat composition and location	Changing habitat composition will benefit species that utilize the new habitat type
Droughts	Periods in which rainfall falls below the normal range of variation	
Temperature Extremes	Periods in which temperatures exceed or go below the normal range of variation	
Storms and Flooding	Extreme precipitation and/or wind events	Wind events can result in the creation of early successional habitats, benefiting some wildlife species

Table 3-2. Characteristics and rankings used to summarize stressors assigned to SGCN and Habitats. Adapted from Crisfield et al. 2013.

Stressor Characteristic	Low Impact	Moderate Impact	High Impact
Severity	**Slight Severity**: Degree of ecological change is minor	**Moderate Severity:** Degree of ecological change is substantial	**Severe:** Degree of ecological change is major
Actionability (Consider the likelihood of implementing conservation actions to begin reducing the impact of the Stressor within the next 10 years)	**Actionable with Difficulty:** Impacts of a Stressor can only be minimally reversed, prevented, or mitigated, and cost or logistics make solutions difficult to implement	**Moderately Actionable:** Impacts of a Stressor can be reversed, prevented, or mitigated, however solutions are only partially effective <u>or</u> may be difficult to implement	**Highly Actionable:** Impacts of the Stressor can be reversed, prevented, or mitigated with proven strategies, at relatively low costs and with few logistical difficulties
Reversibility (Consider the likelihood of reversing the impacts within 10 years)	**Reversible:** Effects of the threat can be reversed by proven actions	**Reversible with difficulty:** effects of the threat may be reversed but costs or logistics make action impractical	**Irreversible:** Effects of the threat are irreversible
Immediacy (This characteristic assesses the time scale over which impacts of the threat will be observable)	**Long-term:** Effects of the threat are expected in 10-100 years given known ecosystem interactions or compounding threats	**Near-term:** Effects of the threat are expected within the next 1-10 years	**Immediate:** Effects of the threat are immediately observable (current or existing)
Spatial Extent (Consider the impact of threat within 10 years)	**Localized:** (<10%) A small portion of the habitat or population is negatively impacted by the threat.	**Dispersed or Patchy:** (10-50%)	**Pervasive:** (>50%) A large portion of the habitat or population is negatively impacted by the threat.
Certainty (This characteristic is used to assess the certainty surrounding the threat and its impacts)	**Low Certainty:** threat is poorly understood, data are insufficient, or the response to threat is poorly understood	**Moderate Certainty:** some information describing the threat and ecological responses to it is available, but many questions remain	**High Certainty:** Sufficient information about the threat and ecological responses to it is available
Likelihood (Consider impact of the threat within 10 years.)	**Unlikely:** Effects of the threat are unlikely to occur (less than 30% chance)	**Likely:** effects of threat are likely to occur (30-99% chance)	**Occurring:** effects of the threat are already observable (100% chance)

We added an additional characteristic – 'Actionability' – in order to more explicitly indicate the relative ease with which the impact of the stressor could be addressed through prevention, restoration, or mitigation. We determined that a stressor is 'Actionable' if either the stressor itself, or the impact of the stressor, can be reversed, prevented, or mitigated in some way. Conceptually, 'Actionability' is similar to, but distinct from the concept of 'Reversibility'. While 'Reversibility' considers only whether the impact of the stressor can be reversed once it occurs, 'Actionability' incorporates the idea that preventing or mitigating the impact of a stressor can be just as effective, and in some cases more desirable, than reversing the impact once it has already occurred. For example, expected shifts or changes in habitats due to sea level rise may not be reversible, but the impacts of seas level rise on a salt marsh may be partially mitigated if space for the marsh to migrate inland is available. Similarly, the loss of habitat from existing housing and urban development is not reversible, but some impacts of development, such as run-off, may be actionable.

3.1.4 ASSIGNING AND PRIORITIZING STRESSORS FOR SGCN

We assigned stressors to Priority 1 and Priority 2 SGCN and assigned 'Severity' and 'Actionabilty' characteristics for each stressor – SGCN interaction (Table 3-2). We considered the concepts of 'Likelihood', 'Certainty' and 'Spatial Extent' implicitly, and only assigned those Stressors that we believed had a moderate or high impact for each of these characteristics. In addition, we only assigned those stressors with moderate or high severity to SGCN. Using this approach, we excluded those stressors with low importance for a particular species from further consideration, in recognition that these low-priority issues were not likely to be considered for conservation action if they only impacted a single SGCN or were not impacting a habitat.

In addition, we developed a simple matrix to prioritize SGCN stressors, using the combination of the Impact scores for 'Severity' and 'Actionability' (Figure 3-1). We considered these priority levels during the assignment of Conservation Actions (see Element 4).

Figure 3-1. SGCN Stressor Priority Level based on Severity and Reversibility.

		Severity	
		Moderate	**Severe**
Actionability	**Highly Actionable**	Medium - High	High
	Moderately Actionable	Medium	Medium - High
	Actionable with Difficulty	Low	Low

3.1.5 ASSIGNING STRESSORS FOR HABITATS

We identified stressors for terrestrial and freshwater aquatic habitats using Anderson et al. (2013) as our primary of reference. Because no single comprehensive source is available that describes the state of marine habitats along Maine's coast, we used a wide variety of scientific publications, which are listed in the Literature Cited, to compile information on stressors. We assumed that the habitat systems within each terrestrial and marine macrogroup all faced similar conservation problems; therefore we assigned stressors to each macrogroup, but did not identify stressors separately for each habitat system. However, because we determined that the macrogroups for freshwater aquatic habitats (River and Streams, and Lakes and Ponds) were too coarse for assigning stressors in a meaningful way, we identified stressors separately for each of these systems. Unlike our approach for SGCN, we assigned all 7 stressor characteristics (Table 3-2) for each habitat – stressor combination.

Although we acknowledge that there may be stressors that we did not list, we attempted to assign all known stressors for each habitat, regardless of severity or impact level for other characteristics. Our stressor assignments for habitats were intended to be comprehensive, in recognition that over the long term, relatively minor problems within a habitat could have important implications for large numbers of SGCN. In addition, this approach increased the likelihood that a problem would be identified for potential conservation attention if it impacted a species' habitat, even if it was not assigned for an SGCN because it was of slight severity.

Utility and service corridors, such as this powerline, may have positive benefits for SGCN by providing a source of early successional habitat that is lacking in much of southern Maine. © Department Inland Fisheries and Wildlife

In contrast to our approach for SGCN, we did not use a formal ranking system to prioritize stressors to habitats. Instead, we convened a group of experts to review the stressor information for each habitat and determine which stressors required attention (see Element 4). We considered stressor characteristics during this qualitative process, but did not use them to determine which stressors required attention.

3.2 STRESSORS TO SGCN

We assigned 38 unique stressors to 190 Priority 1 and Priority 2 SGCN species, for a total of 1,099 SGCN – stressor combinations. Because of the complexity of species-specific stressors and the sheer volume of information, we did not attempt to summarize and discuss all stressors, but instead refer the reader to reports for individual species. However, for ease of reference, we developed Table 3-3, which is includes a list of the Secondary (Level 2) IUCN threat categories and the number of Priority 1 and 2 SGCN, as well as the number of Habitat Macrogroups, that are associated with each category. Complete stressor reports can be downloaded by clicking on the hyperlinks embedded within the table.

We identified 'Habitat Shifting or Alteration' (mostly due to expected climate changes or sea level rise), 'Lack of Knowledge', and 'Fishing and Harvesting of Aquatic Resources' as stressors for the largest number of SGCN, affecting 108, 109, and 69 species, respectively (Table 3-3). Each of these stressors impacted more than one-third of all Priority 1 and Priority 2 SGCN, indicating that they are wide-spread issues that occur across taxonomic groups. However, a simple evaluation of the numbers of species impacted by each stressor does not necessarily translate into priority for conservation attention. In fact, our assessment indicated that a relatively small number of SGCN stressors were both highly severe and highly actionable, resulting in a high priority ranking (Figure 3-2). We classified only 30% of SGCN stressors as either high or medium-high priority for action, indicating that they were both severe enough to warrant immediate attention, and that solutions are available to mitigate, reverse, or prevent the impact of the stressor. In fact, of the 38 unique stressors assigned to SGCN, we determined that only 28 were of medium-high or high priority for one or more species.

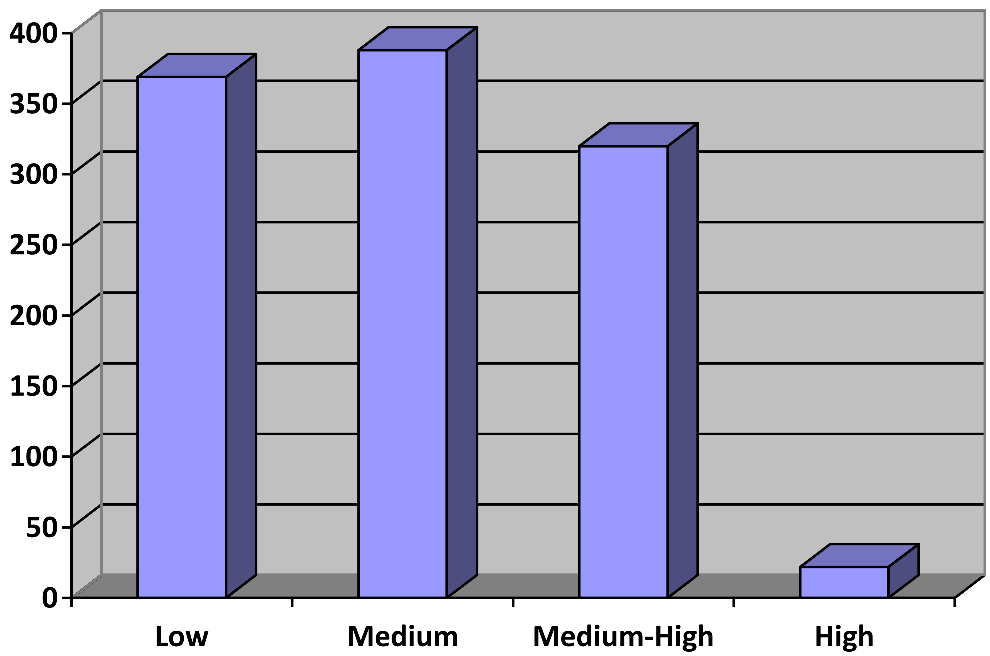
Table 3-3. IUCN Threat Category and the Number of Priority 1 SGCN, Priority 1 SGCN, and Habitat Macrogroups associated with each category. Complete stressor reports can be downloaded by clicking on the hyperlinks within the table.

IUCN Threat Category	Priority 1 SGCN	Priority 2 SGCN	Total SGCN	Habitat Macrogroups
Residential and Commercial Development				
Housing and Urban Areas	27	34	61	19
Commercial and Industrial Areas	20	17	37	18
Tourism and Recreational Areas	6	0	6	6
Agriculture and Aquaculture				
Annual and Perennial Non-timber crops	9	18	27	7
Livestock Farming and Ranching	3	3	6	6
Marine and Freshwater Aquaculture	1	0	1	5
Energy Production and Mining				
Oil and Gas Drilling	9	12	21	0
Mining and Quarrying	8	10	18	7
Renewable Energy	13	16	29	10
Transportation and Service Corridors				
Roads and Railroads	16	24	40	19
Utility and Service Lines	5	3	8	15
Shipping Lanes	4	4	8	11
Biological Resource Use				
Hunting and Collecting Terrestrial Animals	4	4	8	0
Gathering Terrestrial Plants	0	0	0	1
Logging and Wood Harvesting	12	16	28	9
Fishing and Harvesting of Aquatic Resources	21	48	69	11
Human Intrusions and Disturbance				
Recreational Activities	22	28	50	18
War, Civil Unrest and Military Exercises	2	4	6	0
Work and Other Activities	1	1	2	0
Natural Systems Modifications				
Fire and Fire Suppression	3	16	19	5
Dams and Water Management-Use	19	15	34	8
Other Ecosystem Modifications	5	5	10	0

Table 3-3. *continued: page 2 of 2.*

IUCN Threat Category	Priority 1 SGCN	Priority 2 SGCN	Total SGCN	Habitat Macrogroups
Invasive and Other Problematic Species, Genes and Diseases				
Invasive Non-native-Alien Species-Diseases	25	39	64	27
Problematic Native Species-Diseases	8	15	23	8
Problematic Species-Diseases of Unknown Origin	1	2	3	1
Viral-Prion-induced Diseases	0	2	2	2
Diseases of Unknown Cause	0	1	1	0
Pollution				
Domestic and Urban Waste Water	12	24	36	19
Industrial and Military Effluents	23	40	63	18
Agricultural and Forestry Effluents	14	53	67	17
Garbage and Solid Waste	5	7	12	7
Air-Bourne Pollutants	4	2	6	3
Excess Energy	3	7	10	0
Climate Change and Severe Weather				
Habitat Shifting or Alteration	33	75	108	20
Droughts	6	2	8	2
Temperature Extremes	20	45	65	9
Storms and Flooding	15	13	28	9
Other Options				
Other Threat	0	6	6	0
Lack of knowledge	31	78	109	1

Figure 3-2. Number of SGCN stressor assignments categorized as low, medium, medium-high, and high priority.



We identified 'Lack of Knowledge', 'Agricultural and Forestry Effluents', and 'Fishing and Harvesting of Aquatic Resources' as medium-high or high priority stressors for the largest number of SGCN (Table 3-4). Interestingly, 'Habitat Shifting or Alteration', which we found to impact a large number of SGCN, was identified as a priority stressor for only five SGCN. In most cases, impacts from 'Habitat Shifting or Alteration' were related to changes in habitat that will occur as a result of predicted levels of climate change. Common examples include the direct impacts of increasing seawater temperatures on coastal species, effects of shifts in forest composition on terrestrial species, and loss of saltmarsh habitat due to sea level rise. Although these effects are diverse and statewide in scope, most are not highly actionable at the level of individual SGCN within the scope of an individual state's Wildlife Action Plan, or are not predicted to have severe impacts on those species. However, we fully recognize the long-term implications of climate change for SGCN in Maine, and address these issues more fully at the coarse-filter (habitat) scale. We also refer readers to Whitman et al. (2013) for more information on the potential impacts of climate change on SGCN and their habitats in Maine.

Unlike 'Climate Change', 'Lack of Knowledge' is often highly actionable at the level of individual SGCN, and in many cases is one of the most severe stressors impacting species in Maine. In particular, Maine's invertebrate and marine fauna are generally poorly studied, and little information exists to describe distribution, trends in abundance, or limiting factors. Gathering basic ecological information on these species will be fundamental to advancing their conservation over the next 10 years.

Table 3-4. Secondary IUCN Threat Categories and the number of Priority 1 and Priority 2 SGCN assigned to each category where the stressor was ranked as either high or medium-high priority for action. Complete stressor reports can be downloaded by clicking on the hyperlinks within the table.

IUCN Threat Category	Number of SGCN Assignments
Residential and Commercial Development	
Housing and Urban Areas	25
Commercial and Industrial Areas	4
Tourism and Recreational Areas	1
Agriculture and Aquaculture	
Livestock Farming and Ranching	1
Marine and Freshwater Aquaculture	1
Energy Production and Mining	
Mining and Quarrying	2
Renewable Energy	12
Transportation and Service Corridors	
Roads and Railroads	12
Utility and Service Lines	1
Biological Resource Use	
Hunting and Collecting Terrestrial Animals	1
Logging and Wood Harvesting	8
Fishing and Harvesting of Aquatic Resources	39
Human Intrusions and Disturbance	
Recreational Activities	21
Work and Other Activities	1
Natural Systems Modifications	
Fire and Fire Suppression	13
Dams and Water Management-Use	12
Other Ecosystem Modifications	4
Invasive and Other Problematic Species, Genes and Diseases	
Invasive Non-native-Alien Species-Diseases	4
Problematic Native Species-Diseases	8
Viral-Prion-induced Diseases	1
Diseases of Unknown Cause	1

Table 3-4. *continued: page 2 of 2.*

IUCN Threat Category	Number of SGCN Assignments
Pollution	
Domestic and Urban Waste Water	19
Industrial and Military Effluents	18
Agricultural and Forestry Effluents	46
Air-Bourne Pollutants	1
Climate Change and Severe Weather	
Habitat Shifting or Alteration	5
Storms and Flooding	6
Other Options	
Other Threat	1
Lack of knowledge	74

The types of 'Agricultural and Forestry Effluents' that impact SGCN in Maine are diverse, and include pesticides, excessive nutrients, sedimentation, and the release of heavy metals. Many insect SGCN can be negatively impacted by the application of agricultural pesticides intended to control other species. Although these effects can be severe, they are often actionable through slight modifications to pesticide application methods, changes in the types of pesticides used, or in some cases, use of alternate pest control methods. Freshwater Aquatic and Marine habitats, and their associated SGCN, are often sensitive to declines in water quality, which can be caused by both point-source and non-point-sources. Excessive nutrients and sedimentation from agricultural activities (both crop and livestock operations) and finfish aquaculture facilities can cause elevated algae growth and lead to reduced levels of dissolved oxygen. Slight changes to farming practices are often sufficient to reduce nutrient and sediment migration to aquatic habitats and many programs currently exist to assist agricultural producers with these efforts. Established industry standards addressing feeding rates and stocking densities have successfully mitigated most effects from finfish aquaculture, drastically reducing algal growth and improving water quality.

We identified 'Fishing and Harvesting of Aquatic Resources' as a medium-high or high priority stressor for 39 SGCN. In most cases, these impacts are related to overfishing of commercial species or accidental by-catch of non-target species. Because there is no commercial harvest of terrestrial or freshwater SGCN, these impacts are limited to marine species. Often, these are historic issues that have largely been addressed through changes in regulations or fishing practices, however stocks of some species are slow to recover. Commercial fishing for marine species is a staple industry in Maine, and addressing past and current impacts will ensure that this important industry can continue to operate sustainably.

3.3 STRESSORS TO HABITATS

We assigned 31 unique stressors to 34 habitat macrogroups, for a total of 326 habitat – stressor combinations. Similar to SGCN, we do not attempt to summarize and discuss all stressors, but instead refer the reader to reports for individual habitats, and to Table 3-3 which includes links to summary reports for each stressor.

Poorly planned residential development proximate to a high value vernal pool, which has degraded terrestrial habitat for amphibians and is leaching excessive nutrients into the pool depression. © Department Inland Fisheries and Wildlife

We assigned 'Invasive Non-native/Alien Species/Diseases' and development (comprised of 'Roads and Railroads', and 'Housing and Urban Areas') to the largest number of habitats. Although all of these issues occur statewide and have the potential to impact virtually every habitat in Maine, their impacts on SGCN differ markedly depending on geography and the sensitivity of the individual speces.

Impacts from 'Invasive Non-native/Alien Species/Diseases' are most commonly related to invasive plant and animal species that degrade habitats or directly displace native species through competition or predation. These issues tend to be more prevalent in southern Maine, where higher human populations and a moderate climate facilitate expansion of non-native species. In the marine environment, green crabs are a prevalent invasive species with deleterious impacts on a variety of habitats and SGCN. In some cases, non-native diseases, such as white-nosed syndrome in bats, have also had devastating impacts on SGCN. Impacts from 'Invasive Non-native/Alien Species/Diseases' can be severe, and in many cases it is extremely difficult to reverse the spread of invasive species or diseases; prevention is often the only feasible solution.

In contrast, 'Roads and Railroads' tend to impact habitats through fragmentation, especially for aquatic species, and by altering hydrology. Improperly installed or sized culverts can prevent or reduce passage by many SGCN, reducing connectivity between habitat patches. Both roads and railroads can also impede water flowage in seepage forests, tidal marshes, mudflats, and floodplains, reducing the function of these habitats. Construction of new roads and railroads is not prevalent in most of Maine, so addressing impacts from this stressor typically involves partial reconstruction of existing infrastructure through installation of improved culverts and bridges, and for the sake of terrestrial species such as turtles, installing signage to alert motorists to slow down.

> *"Development of Housing and Urban Areas is most prevalent in southern Maine, where most of Maine's human population lives, and where populations are expected to increase over the next two decades"*

Development of 'Housing and Urban Areas' is most prevalent in southern Maine, where most of Maine's human population lives, and where human populations are expected to increase over the next two decades (Maine Office of Policy and Management 2015). Conversion of forest or agricultural land to residential areas causes a net loss of habitat for most species, although some SGCN are capable of adapting to development. In many cases, secondary impacts from development, such as increases in run-off, pollution, off-leash pets, traffic volumes, and even foot traffic, can have greater impacts on SGCN than the development itself. Outside of southern Maine, human populations are predicted to stabilize or decline over the next 20 years, so future impacts from new housing development are likely to be localized and should have relatively minor impacts on SGCN.

Hemlock tree in York County infected with hemlock wooly adelgid, a non-native pest. © Phillip DeMaynadier

3.4 LITERATURE CITED AND REFERENCES

Allen, R. B. 2000. Common Eider assessment. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 50pp.

Allen, R. B. 2004. Maine Colonial Waterbird Inventory. Page 54 *In:* Wildlife Division Research & Management Report 2004. Maine Department of Inland Fisheries and Wildlife, Augusta Mane. 78pp.

Anderson, M. G., M. Clark, C. E. Ferree, A. Jospe, A. Olivero Sheldon and K. J. Weaver. 2013. Northeast Habitat Guides: A companion to the terrestrial and aquatic habitat maps. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, Massachussetts. http://nature.ly/HabitatGuide.

Anderson, P.J. 2000. Pandalid shrimp as indicators of ecosystem regime shift. Journal of Northwest Atlantic Fisheries Science 27:1-10.

Appelhans, Y. S., J. Thomsen, C. Pinch, F. Melzner, and M. Wahl. 2012. Sour times: seawater acidification effects on growth, feeding behaviour and acid-base status of *Asterias rubens* and *Carcinus maenas*. Marine Ecology Progress Series 459:85-97.

Armstrong, C, and J Falk-Peterson. 2008. Habitat–fisheries interactions: a missing link? – ICES Journal of Marine Science 65:817–821.

Association of Fish and Wildlife Agencies, Teaming With Wildlife Committee, State Wildlife Action Plan (SWAP) Best Practices Working Group. 2012. Best Practices for State Wildlife Action Plans—Voluntary Guidance to States for Revision and Implementation. Washington (DC): Association of Fish and Wildlife Agencies. 80pp.

Atlantic Leatherback Turtle Recovery Team. 2006. Recovery strategy for leatherback turtle (*Dermochelys corriacea*) in Atlantic Canada. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. 45pp.

Auster, P. J., R. J. Malatesta, R. W. Langton, L. Watting, P. C. Valentine, C. L. S. Donaldson, E. W. Langton, A. N. Shepard and W. G. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the gulf of Maine (Northwest Atlantic): Implications for conservation of fish populations. Reviews in Fisheries Science 4(2):185-202.

Bailey, H., K. L. Bookes, and P.M. Thompson. 2014. Assessing environmental impacts of offshore wind farms: lessons learned and recommendations for the future. Aquatic Biosystems 10:8.

Barsiene, J., V. Dedonyte, A. Rybakovas, L. Andreikenaite, and O. K. Andersen. 2006. Investigation of micronuclei and other nuclear abnormalities in peripheral blood and kidney of marine fish treated with crude oil. Aquatic Toxicology 78(Supplement 1): S99-S104.

Bates, A. E., B. J. Hilton, and C. D. Harley. 2009. Effects of temperature, season and locality on wasting disease in the keystone predatory sea star *Pisaster ochraceus*. Diseases of Aquatic Organisms 86:245-251.

Baum, J. K., Myers, R. A., Kehler, D. G., Worm, B., Harley, S. J., and P. A. Doherty. 2003. Collapse and conservation of shark populations in the Northwest Atlantic. Science 17 299:389-392.

Birchenough, S. N. R., H. Reiss, S. Degraer, N. Mieszkowska, Á. Borja, I. Buhl-Mortensen, U. Braeckman, J. Craeymeersch, I. De Mesel, F. Kerckhof, I. Kröncke, S. Parra, M. Rabaut, A. Schröder, C. Van Colen, G. Van Hoey, M. Vincx and K. Wätjen. 2015. Climate change and marine benthos: a review of existing research and future directions in the North Atlantic. WIREs Clim Change, 6:203–223.

Black, D.E., D. K. Phelps, and R.L. Lapan. 1988. The effect of inherited contamination on egg and larval winter flounder, *Pseudopleuronectes americanus*. Marine Environmental Research 25:45-62.

Blinn, B. M., A. W. Diamond, and D. J. Hamilton. 2008. Factors affecting selection of brood-rearing habitat by Common Eiders (*Somateria mollissima*) in the Bay of Fundy, New Brunswick, Canada. Waterbirds: The International Journal of Waterbird Biology 31(4):520-529.

Brooks, D. A., M. W. Baca, and Y.-T. Lo. 1999. Tidal circulation and residence time in a macrotidal estuary: Cobscook Bay, Maine. Estuarine, Coastal and Shelf Science 49:647-665.

Brousseau, D. J. and R. Goldberg. 2007. Effect or predation by the invasive crab *Hemigrapsus sanguineus* on recruiting barnacles *Semibalanus balanoides* in western Long Island Sound, USA. Marine Ecology Progress Series 339:221–228.

Brown, B .E., J. A. Brennan, M. D. Grosslein, E. G. Heyerdahl, and R. C. Hennemuth. 1976. The effect of fishing on the marine finfish biomass in the Northwest Atlantic from the Gulf of Maine to Cape Hatteras. International Commission for the Northwest Atlantic Fisheries Research Bulletin 12:49-68.

Burridge L, J. S. Weis, F. Cabello, J. Pizarro, and K. Bostick. 2010. Chemical use in salmon aquaculture: a review of current practices and possible environmental effects. Aquaculture 306:7–23.

Carey, F. G., J. V. Scharold, and Ad. J. Kalmign. 1990. Movements of blue sharks (*Prionace glauca*) in depth and course. Marine Biology 106:329-342.

Carrington, E., J. Herbert Waite, G. Sar`a, and K. P. Sebens. 2015. Mussels as a model system for integrative ecomechanics. Annual review of Marine Science 7:9.1 – 19.27.

Caswell, H., S. Brault, A. J. Read, and T. D. Smith. 1998. Harbor porpoise and fisheries: An uncertainty analysis of incidental mortality. Ecological Applications 8:1226-1238.

Chase, M. E., S. H. Jones, P. Hennigar, J. Sowles, G. C. H. Harding, K. Freeman, P. G. Wells, C. Krahforst, K. Coombs, R. Crawford, J. Pederson, and D. Taylor. 2001. Gulfwatch: Monitoring spatial and temporal patterns of trace metal and organic contaminants in the Gulf of Maine (1991-1997) with the blue mussel, *Mytilus edulis L*. Marine Pollution Bulletin 42:490-504.

Chen, Y., and M. Hunter. 2003. Assessing the green sea urchin (*Strongylocentrotus drobachiensis*) stock in Maine, USA. Fisheries Research 60:527-537.

Cheung, W.W.L., V. W. Y. Lam, J. L. Sarmiento, K. Kearney, R. Watson, and D. Pauly. 2009. Projecting global marine biodiversity impacts under climate change scenarios. Fish and Fisheries 10:235-251.

Clapham, P. J., S. B. Young, and R. L. Brownell, Jr. 2002. Baleen whales: conservation issues and the status of the most endangered populations. Mammal Review 29:37-62.

Clark, K. E. and L. J. Niles. 2001. Northern Atlantic Regional Shorebird Plan, ver. 1. Endangered and Nongame Species Program, New Jersey Division of Fish and Wildlife, Woodbine, NJ.

Clark, S. H., S. X. Cadrin, D. F. Schick, P. J. Diodati, M. P. Armstrong, and D. McCarron. 2000. The Gulf of Maine northern shrimp (*Pandalus borealis*) fishery: A review of the record. Journal of Northwest Atlantic Fishery Science 27:193-226.

Clements, J. C., and H. L. Hunt. 2014. Influence of sediment acidification and water flow on sediment acceptance and dispersal of juvenile soft-shell clams (*Mya arenaria L.*). Journal of Experimental Marine Biology 453:62-69.

Collie, J. S., S. J. Hall, M. J. Kaiser, and I. R. Poiners. 2000. A quantitative analysis of fishing impacts on shelf-sea benthos. Journal of Animal Ecology 69:785–798.

Colwell, Mark A. 2010. Shorebird ecology, conservation, and management. University of California Press, Berkeley, California.

Comeau, S., G. Gorsky, R. Jeffree, J. L. Teyssie, and J.P. Gattuso. 2009. Impact of ocean acidification on a key Arctic pelagic mollusc (*Limacina helicina*). Biogeosciences 6: 1877-1882.

COSEWIC. 2012. Assessment and status report on the Spotted Wolfish Anarhichas minor in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 44pp. Available at http://www.registrelep-sararegistry.gc.ca/virtual_sara/files/cosewic/sr_loupe_tachete_spotted_wolffish_1113_e.pdf.

Couillard, C. M., K. Lee, B. Légaré, and T. L. King. 2005. Effect of dispersant on the composition of the water-accommodated fraction of crude oil and its toxicity to larval marine fish. Environmental Toxicology and Chemistry 24:1496–1504.

Crain C. M., K. Kroeker, and B. S. Halpern. 2008. Interactive and cumulative effects of multiplehuman stressors in marine systems. Ecology Letters 11:1304–1315.

Crisfield, E. and the Northeast Fish and Wildlife Diversity Technical Committee (NFWDTC). 2013. The Northeast Lexicon: Terminology Conventions and Data Framework for State Wildlife Action Plans in the Northeast Region. A report submitted to the Northeast Fish and Wildlife Diversity Technical Committee. Terwilliger Consulting, Inc., Locustville, VA.

Dettmers, R. 2005. *Blueprint for the Design and Delivery of Bird Conservation in the Atlantic Northern Forest* , http://www.acjv.org/pdf_files/BCR%2014%20Blueprint.pdf.

DFO. 2012. Assessment of winter flounder (*Pseudopleuronectes americanus*) in the southern Gulf of St. Lawrence (NAFO Div. 4T). DFO Canadian Science Advisory Secretariat Science Advisory Report 2012/016.

Dimitriadis C., and D. Koutsoubas. 2011. Functional diversity and species turnover of benthic invertebrates along a local environmental gradient induced by an aquaculture unit: the contribution of species dispersal ability and rarity. Hydrobiologia 670:307–31.

Dixon, D. L., A. R. Jennings, and J. Atema. 2014. Odor tracking in sharks is reduced under future ocean acidification conditions. Global Change Biology 21:1454-1462.

Duffy J. E. (2003). Biodiversity loss, trophic skew and ecosystem functioning. Ecology Letters 6:680–687.

Dulvy N. K., Y. Sadovy, and J. D. Reynolds. 2003. Extinction vulnerability in marine populations. Fish and Fisheries 4:25-64.

Dupont, S., O. Ortega-Martinínez, and M. Thorndyke. 2010. Impact of near-future ocean acidification on echinoderms. Ecotoxicology 19:449-462.

Edgar G. J., C. K. Macleod, R. B. Mawbey, and D. Shield. 2005. Broad-scale effects of marine salmonid aquaculture on macrobenthos and the sediment environment in southeastern Tasmania. Journal of Experimental Marine Biology and Ecology 327:70–90.

Edgar G.J. and C. R. Samson. 2004. Catastrophic decline in mollusc diversity in eastern Tasmania and its concurrence with shellfish fisheries. Conservation Biology 18:1579–1588.

Erwin, R. M. 1989. Responses to human intruders by birds nesting in colonies: experimental results and management guidelines. Colonial Waterbirds 12(1):104-108.

Famous, N. C. 1987. The conservation and ecology of migratory shorebird roosting sites in eastern Maine. Unpub rep. 7pp.

Findlay, R.H., L. Watling, and L.M. Mayer. 1995. Environmental impact of salmon net-pen culture on marine benthic communities in Maine: A case study. Estuaries 18:145-179.

Floyd T., and J. Williams. 2004. Impact of green crab (*Carcinus maenas* L.) predation on a population of soft-shell clams (*Mya arenaria* L.) in the southern Gulf of St. Lawrence. Journal of Shellfish Research 23:457–462.

Fogarty, M., L. Incze, K. Hayhoe, D. Mountain, and J. Manning. 2007. Potential climate change impacts on Atlantic cod (Gadus morhua) off the northeastern USA. Mitigation and Adaptation Strategies for Global Change 13: 453-466.

Fogarty M., K. D. Friedland, L. Col, R. Gamble, J. Hare, K. Hyde, J. S. Link, S. Lucey, H. Liu, J. Nye, W. J. Overholtltz, D. Richardson, B. Roundtree and M. Taylor. 2012. Status of the Northeast US continental shelf Large Marine Ecosystem: an indicator-based approach. American Fisheries Society Symposium 79:1 – 28.

Fromentin, J. M. and J. E. Powers. 2005. Atlantic bluefin tuna: Population dynamics, ecology, fisheries and management. Fish and Fisheries 6:281-306.

Galbraith H., D. W. DesRochers, S. Brown, and J. M. Reed. 2014. Predicting Vulnerabilities of North American Shorebirds to Climate Change. PLoS ONE 9(9):e108899.

Gallagher, A.J., E. S. Orbesen, N. Hammerschlag, and J. E. Serafy. 2014. Vulnerability of oceanic sharks as pelagic longline bycatch. Global Ecology and Conservation 1:50-59.

Gaskin D. E., and G. J. D. Smith. 1979. Observations on marine mammals, birds and environmental conditions in the Head Harbor region of the Bay of Fundy. In: Scarratt DJ (ed) Evaluation of the recent data relevant to potential oil spills in the Passamaquoddy area. Fishery Marine Service Technical Report 901:69–86.

Gehrels, W.R., D. F. Belknap, S. Black, and R. M. Newnham. 2002. Rapid sea-level rise in the Gulf of Maine, USA, since AD 1800. The Holocene 12:383-389.

Gerrodette T., P. K. Dayton, S. Macinko, and M. J. Fogarty. 2002. Precautionary management of marine fisheries: moving beyond burden of proof. Bulletin of Marine Science 70:657–668.

Gilbert, M. A. 1977. The Gaper Clam (*Mya truncata*) in Maine and its relavance to the Critical Area Program of the State Planning Office. Maine Critical Areas Program of the State Planning Office. Maine Critical Areas Program Report 29:1-16.

Gill, A. B., Y. Huang, I. Gloyne-Phillips, J. Metcalfe, V. Quayle, J. Spencer, and V. Wearmouth. 2009. COWRIE 2.0 Electromagenetic Fields (EMF) Phase 2: EMF-sensitive fish response to EM emissions from sub-sea electricity cables of the type used by the offshore renewable energy industry. Commissioned by COWRIE Ltd (project reference COWRIE-EMF-1-06). http://www.thecrownestate.co.uk/media/5924/km-ex-pc-emf-032009-cowrie-20-electromagnetic-fields-emf-phase-2.pdf.

Glude, J. B. 1955. The effects of temperature and predators on the abundance of the soft-shell clam, *Mya arenaria*, in New England. Transactions of the American Fisheries Society 84:13-26.

Goldburg, R. J., M. S. Elliott, and R. L. Naylor. Marine aquaculture in the United States: Environmental Impacts and Policy Options. Prepared for the Pew Oceans Commission. http://www.iatp.org/files/Marine_Aquaculture_in_the_United_States_Enviro.htm.

Greene, K .E., J. L. Zimmerman, R. W. Laney, and J. C. Thomas-Blate. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations for conservation, and research needs. Atlantic States Marine Fisheries Commission Habitat Management Series No. 9, Washington, D.C.

Hall, C., A. Jordaan, M. Frisk. 2012. Centuries of Anadromous Forage Fish Loss: Consequences for Ecosystem Connectivity and Productivity. BioScience 62(8):723-731.

Hall, C. J., Jordaan, A., and M. G. Frisk. 2011. The historic influence of dams on diadromous fish habitat with a focus on river herring and hydrologic longitudinal connectivity. Landscape Ecology 26:95-107.

Hamilton, D. J. 2001. Feeding behavior of common eider ducklings in relation to availability of rockweed habitat and duckling age. Waterbirds: The International Journal of Waterbird Biology 24(2): 233-241.

Hamilton, D. J. and T. D. Nudds. 2003. Effects of predation by common eiders (*Somateria mollissima*) in an intertidal rockweed bed relative to an adjacent mussel bed. Marine Biology 142:1-12.

Hansen, L. P., and M. L. Windsor. 2006. Interactions between aquaculture and wild stocks of Atlantic salmon and other diadromous fish species: Science and management, challenges and solutions. ICES Journal of Marine Sciences 63:1159-1161.

Harvell, C. D., K. Kim, J. M. Burkholder, R. R. Colwell, P. R. Epstein, D. J. Grimes, E. E. Hofmann, E. K. Lipp, A. D. M. E. Osterhaus, R. M. Overstreet, J. W. Porter, G. W. Smith, and G. R. Vasta. 1999. Emerging marine diseases – Climate links and anthropogenic factors. Science 285:1505-1510.

Heilmayer, O., T. Brey, and H. O. Pörtner. 2004. Growth efficiency and temperature in scallops: a comparative analysis of species adapted to different temperatures. Functional Ecology, 18(5):641-647.

Holtmann, W. C., M. Stumpp, M. A. Gutowska., S. Syre, N. Himmerkus, F. Melzner, and M. Bleich. 2013. Maintenance of coelomic fluid pH in sea urchins exposed to elevated CO2: the role of body cavity epithelia and stereom dissolution. Marine Biology 160: 2631-2645. http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme. Accessed May 29, 2015.

Hudon, C. 1990. Distribution of shrimp and fish by-catch assemblages in the Canadian eastern Arctic in relation to water circulation. Canadian Journal of Fisheries and Aquatic Sciences, 47(9):1710-1723.

Hvingel, C., and M. C.S . Kinsgley. 2006. A framework to model shrimp (Pandalus borealis) stock dynamics and to quantify the risk associated with alternative management options, using Bayesian methods. ICES Journal of Marine Science 63:68-82.

International Union for Conservation of Nature (IUCN). 2015. Threat Classification Scheme (version 3.2). Available at http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme. Last accessed: May 29, 2015.

Jackson, J. B. 2001. What was natural in the coastal oceans? Proceedings of the National Academy of Science USA 98:5411–5418.

Jackson, J. B. C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H. S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S. Teneck, M. J. Tegner, and R. R. Warner. Historical overfishing and the recent collapse of coastal ecosystems. Science 293:629-637.

Jelks, H. L., S. J. Walsh, N. M. Burkhead, S. Contreras-Balderas, E. Diaz-Pardo, D. A. Hendrickson, J. Lyons, N. E. Mandrak, F. McCormick, J. S. Nelson, S. P. Platania, B. A.

Porter, C. B. Renaud, J. J. Shmitter-Soto, E. B. Taylor, and M. L. Warren Jr. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. Fisheries 33:372-407.

Jenkins S. R., B. D. Beukers-Stewart and A. R. Brand. 2001. Impact of scallop dredging on benthic megafauna: a comparison of damage levels in captured and non-captured organisms. Marine Ecology Progress Series 215:297–301.

Jennings S., J. K. Pinnegar, N. V. Polunin, and K. J. Warr. 2001. Impacts of trawling disturbance on the trophic structure of benthic invertebrate communities. Marine Ecology Progress Series 213:127–142.

Jentoft, S. 1989. Fisheries co-management: Delegating government responsibility to fishermen's organizations. Marine Policy 13(2):137-154.

Johnson A. F., G. Gorelli, S. R. Jenkins, J. G. Hiddink, and H. Hinz. 2015. Effects of bottom trawling on fish foraging and feeding. Proceedins of the Royal Society B 282:2014-2336.

Kappel, C. V. 2005. Losing pieces of the puzzle: Threats to marine, estuarine, and diadromous species. Frontiers in Ecology and the Environment 3:275-282.

Kaiser M. J., K. Ramsay, C. A. Richardson, F. E. Spence, and A. R. Brand. 2000. Chronic fishing disturbance has changed shelf sea benthic community structure. Journal of Animal Ecology 69:494-503.

Keppel, E. A., R. A. Scrosati, and S. C. Courtenay. 2014. Interactive effects of ocean acidification and warming on subtidal mussels and sea stars from Atlantic Canada. Marine Biology Research 11(4):337-348.

Kingsley, M. C. S., P. Kanneworff, and D. M. Carlsson. 1999. By-catches of fish in the West Greenland shrimp survey: an initial analysis. NAFO SCR Document 111.

Kulka, D. W., M. R. Simpson, and the Department of Fisheries and Oceans. 2004. Determination of allowable harm for spotted (*Anarhichas minor*) and northern (*Anarhichas denticulatus*) wolffish. Canadian Science Advisory Secretariat.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. Acosta Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1. Waterbird Conservation for the Americas, Washington, DC, U.S.A. 78pp. http://www.waterbirdconservation.org/pubs/complete.pdf

Laist, D. W. 1997. Chapter 8: Impacts of marine debris: Entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records." In Marine Debris: Sources, Impacts, and Solutions. Edited by Coe, J.M., and D.B. Rogers. 1997. Springer-Verlag New York, Inc., Ann Arbor, MI. Pp. 99-413.

Larsen, P. F., K. A. Wilson, and D. Morse. 2013. Observations on the expansion of a relict population of Eastern Oysters (*Crassostrea virginica*) in a Maine Estuary: Implications for climate change and restoration. Northeastern Naturalist 20(4):28-32.

Lebel, L., J. M. Anderies, B. Campbell, C. Folke, S. Hatfield-Dodds, T. P. Hughes, and J. Wilson. 2006. Governance and the Capacity to Manage Resilience in Regional Social-Ecological Systems. Marine Sciences Faculty Scholarship. Paper 52.

Limburg, K. E., and J. R. Waldman. 2009. Dramatic declines in North Atlantic diadromous fishes. BioScience 59:955-965.

Lotze, H. K., and I. Milewski. 2004. Two centuries of multiple human impacts and successive changes in a North Atlantic food web. Ecological Applications 14:1428-1447.

Lyons, K., and C. G. Lowe. 2013. Mechanisms of maternal transfer of organochlorine contaminants and mercury in the common thresher shark (*Alopias vulpinus*). Canadian Journal of Fisheries and Aquatic Sciences 70:1667-1672.

Maine Department of Inland Fisheries and Wildlife. 2005. Maine's comprehensive wildlife conservation strategy. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine.

Maine Department of Marine Resources. Historical Maine Fisheries Landings Data. http://www.maine.gov/dmr/commercialfishing/documents/shrimp.graph.pdf

Maine Office of Policy and Management. 2015. Maine State and County Population Projections 2032. http://maine.gov/economist/projections/index.shtml. Accessed May 29, 2015.

Mayor, D. J., C. Matthews, K. Cook, A. F. Zuur, and S. Hay. 2007. CO2-induced acidification affects hatching success in *Calanus finmarchicus*. Marine Ecology Progress Series 350:91-97.

McCauley, D.J., M. L. Pinsky, S. R. Palumbi, J. A. Estes, F. H. Joyce, and R.R. Warner. 2015. Marine defaunation: Animal loss in the global ocean. Science 347:1255641.

McDonald P. S., G. C. Jensen, and D. A. Armstrong. 2001. The competitive and predatory impacts of the nonindigenous crab *Carcinus maenas* (L.) on early benthic phase Dungeness crab *Cancer magister* Dana. Journal of Experimental Marine Biology and Ecology 258:39–54.

Melzner, F., P. Strange, K. Trubenbach, J. Thomsen, I. Casties, U. Panknin, S. N. Gorb, and M. A. Gutowska. 2011. Food supply and seawater pCO_2 impact calcification and internal shell dissolution in the blue mussel *Mytilus edulis*. PloSONE 6: e24223.

Menge, B. A. 1979. Coexistence between the seastars Asterias vulgaris and A. forbesi in a heterogeneous environment: A non-equilibrium explanation. Oecologia 41:245-272.

Merkel, F. R., A. Mosbech and F. Riget. 2009. Common Eider (Somateria mollissima) Feeding Activity and the Influence of Human Disturbances. Ardea 97(1):99-107.

Moul, I. E. 1990. Environmental contaminants and breeding failure at a Great Blue Heron colony on Vancouver Island. M.Sc. thesis. Univ. B.C., Vancouver, B.C.

Musick, J. A., G. Burgess, G. Cailiet, M. Camhi, and S. Fordham. 2000. Management of sharks and their relatives (Elasmobranchii). Fisheries 25:9-13.

Occhipinti-Ambrogi, A. and D. Savini. 2003. Biological invasions as a component of globalchange in stressed marine ecosystems. Marine Pollution Bulletin 46:542–551.

O'Donnell, M. J., M. N. George, and E. Carrington. 2013. Mussel byssus attachment weakened by ocean acidification. Nature Climate Change 3:587-590.

Orr, J. C., V. J. Fabry, O. Aumont, L. Bopp, S. C. Doney, R. A. Feely, A. Gnanadesikan, N. Gruber, A. Ishida, F. Joos, R. M. Key, K. Lindsay, E. Maier-Reimer, R. Matear, P. Monfray, A. Mouchet, R. G. Majjar, G.-K. Plattner, K. B. Rodgers, C. L. Savine, J. L. Sarmiento, R. Schlitzer, R. D. Slater, I. J. Totterdell, M.-F. Weirig, Y. Yamanaka and A. Yool. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature 437:681-686.

Payne, J. F., J. Kicenuik, L. L. Fancey, U. Williams, G. L. Fletcher, A. Rahimtula, and B. Fowler. 1988. What is a safe level of polycyclic aromatic hydrocarbons for fish: Subchronic toxicity study of winter flounder (*Pseudopleuronectes americanus*). Canadian Journal of Fisheries and Aquatic Sciences 45:1983-1993.

Payne, L. X., and E. P. Pierce. 2002. Purple Sandpiper (*Calidris maritima*). In The Birds of North America, no. 706. Edited by A. Poole and F. Gill. The Birds of North America, Inc., Philadelphia, PA.

Peck, L. S., M. S. Clark, D. Power, J. Reis, F. Batista, and E. M. Harper. 2015. Acidification effects on biofouling communities: winners and losers. Global Change Biology 21(5):1907-1913.

Pederson J., N. Mieszkowska, J. T. Carlton, S. Gollasch, A. Jelmert, D. Minchin, A. Occhipinti-Ambrogi, and I. Wallentinus. 2011. Climate change and non-native species in the North Atlantic. Pages 174-256 In ICES Status Report on Climate Change in the North Atlantic. Edited by P. C. Reid and L. Valdés. ICES Cooperative Research Report No 310. 257pp.

Perry, A. L., P. J. Low, J. R. Ellis, and J. D. Reynolds. 2005. Climate change and distribution shifts in marine fishes. Science 308:1912-1915.

Pohle G., B. Frost, R. Findlay. 2001. Assessment of regional benthic impact of salmonmariculture within the Letang Inlet, Bay of Fundy. ICES Journal of Marine Science 58:417–426.

Roberts, D. A., S. N. Birchenough, C. Lewis, M. B. Sanders, T. Bolam, and D. Sheahan. 2013. Ocean acidification increases the toxicity of contaminated sediments. Global Change Biology, 19(2):340-351.

Robertson, G. J. and R. I. Goudie. 1999. Harlequin Duck (Histrionicus histrionicus). In The Birds of North America, no. 706. Edited by A. Poole and F. Gill. The Birds of North America, Inc., Philadelphia, PA.

Robinson S, A. MacIntyre, and S. Bernier. 1994. The impact of scallop drags on sea urchingrounds. In Workshop on the management and biology of the Green Sea Urchin (*Strongylocentrotus droebachiensis*). Edited by J. Harris and H. A. Car. Maine Department of Marine Resources, Boothbay Harbor, Maine, pp 102–123.

Rodgers, J. A., Jr. and H. T. Smith. 1995. Set-back distances to protect nesting bird colonies from human disturbance in Florida. Conservation Biology 9(1):89-99.

Roman, J. 2006. Diluting the founder effect: Cryptic invasions expand a marine invader's range. Proceedings of the Royal Society B 273:2453-2459.

Ruiz G. M., P. W. Fofonoff, J. T. Carlton, M. J. Wonham, and A. H. Hines. 2000. Invasion of coastal marine communities in North America: apparent patterns, processes, and biases. Annual Review of Ecology, Evolution, and Systematics 31:481–531.

Salafsky, N., D. Salzer, J. Ervin, T. Boucher, and W. Ostlie. 2003. Conventions for defining, naming, measuring, combining, and mapping threats in conservation: an initial proposal for a standard system. Conservation Measures Partnership, Washington, D.C.

Salafsky, N. D., A. J. Salzer, A. J. Stattersfield, C. Hilton-Taylor, R. Neugaren, B. H. Buchart, B. Collen, N. Cox, L. L. Master, S. O'Connor, and D. Wilkie. 2008. A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions. Conservation Biology 22 (4):897–911.

Schiel, D. R., J. R. Steinbeck and M. S. Foster. 2004. Ten years of induced ocean warming causes comprehensive changes in marine benthic communities. Ecology 85(7):1833-1839.

Smith, R. M., and C. F. Cole. 1970. Chlorinated hydrocarbon insecticide residues in winter flounder, *Pseudopleuronectes americanus*, from the Weweantic River Estuary, Massachusetts. Journal of the Fisheries Research Board of Canada 27:2374-2380.

Southward, A. J., S. J. Hawkins and M. T. Burrows. 1995. Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. Journal of Thermal Biology 20(1):127-155.

Stachowicz J. J., J. R. Terwin, R. B. Whitlatch, and R. W. Osman. 2002. Linking climate change and biological invasions: ocean warming facilitates nonindigenous species invasions. Proceedings of the National Academy of Sciences 99:15497–15500.

Steneck, R. S. 1997. Fisheries-induced biological changes to the structure and function of theGulf of Maine ecosystem. In Proceedings of the Gulf of Maine ecosystem dynamics scientific symposium and workshop. Edited by G. T. Wallace and E. F. Braasch. Regional Association for Research on the Gulf of Maine, Hanover, New Hampshire. Pp 151–165.

Steneck, R.S., A. Leland, D. C. McHaught, and J. Vavrinec. 2013. Ecosystem flips, locks, and feedbacks: the lasting effects of fisheries on Maine's kelp forest ecosystem. Bulletin of Marine Science 89:31-55.

Stevens, J.D., T. I. Walker, S. F. Cook, and S.V. Fordham. 2005. "Chapter 5: Threats faced by Chondrichthyan fish." In Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey. Edited by S.L. Fowler, R.D. Cavanagh, M. Camhi, G.H. Burgess, G.M. Cailliet, S.V. Fordham, C.A. Simpfendorfer, and J.A. Musick. IUCN, Gland, Switzerland and Cambridge, UK. Pp. 48-57.

Stortini, C.H., N. L. Shackell, P. Tyedmers, and K. Beazley. 2015. Assessming marine species vulnerability to projected warming on the Scotian Shelf, Canada. ICES Journal of Marine Science 72:1731-1743.

Talmage, S. C., and C. J. Gobler. 2009. The effects of elevated carbon dioxide concentrations on the metamorphosis, size, and survival of larval hard clams (Mercenaria mercenaria), bay scallops (Argopecten irradians), and Eastern oysters (Crassostrea virginica). Limnology and Oceanography 54(6):2072-2080.

Talmage, S. C., and C. J. Gobler. 2010. Effects of past, present, and future ocean carbon dioxide concentrations on the growth and survival of larval shellfish. Proceedings of the National Academy of Sciencies of the United States of America 107:17246-17251.

Thrush S. F. and P.K. Dayton. 2002. Disturbance to marine benthic habitats by trawling and dredging: implications for marine biodiversity. Annual Review of Ecology, Evolution, and Systematics 33 449–473.

Todd, C., B. Swartz, P. deMaynadier, and H. Givens. 2003. Maine's Endangered and Threatened wildlife. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 117pp.

Trott, T. J. 2004a. Late 20-th century qualitative intertidal faunal changes in Cobscook Bay, Maine. Northeastern Naturalist 11(Spec Issue 2):325-354.

Trott, T. J. 2004b. Cobscook Bay inventory: A historical checklist of marine invertebrates spanning 162 years. Northeastern Naturalist 11(Spec Issue 2):261-324.

Trott, T. J. (in review). Century-scale species incidence, rareness and turnover in a high diversity Northwest Atlantic coastal embayment. Marine Biodiversity.

Tudor, L. 2002. Coastal migratory shorebird management system and data base. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 50pp.

Tudor, L. 2005. Island-nesting terns assessment. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 38pp.

U.S. Fish and Wildlife Service. 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85pp. [Online version available at http://www.fws.gov/migratorybirds/]

U.S. Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99pp.

U.S. Fish and Wildlife Service. 1996. Pipnig Plover (Charadrius melodus), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachussetts. 258pp.

U.S. Fish and Wildlife Service. 2009. Pipng Plover (Charadrius melodus), 5-Year Review: Summary and Evaluation. Northeast Region, Hadley, Massachussetts and Midwest Region's East Lansing Field Office, MI.

Valentine P. C., M. R. Carman, D. S. Blackwood, and E. J. Heffron. 2007. Ecological observations on the colonial ascidian Didemnum sp. in a New England tide pool habitat. Journal of Experimental Marine Biology and Ecology 342:109–121.

Vandendriessche, S., K. Hostens, W. Courtens, and E. W. M. Stienen. 2011. Monitoring the effects of offshore wind farms: evaluating changes in fishing effort using Vessel Monitoring System data: targeted monitoring results. Offshore Wind Farms in the Belgian part of the North Sea: Selected Findings from the Baseline and Targeted Monitoring. RBINS-MUMM, Brussels, pp 83-92.

Vanderlaan, A. S. M., C. T. Taggart, A. R. Serdynska, R. D. Kenney, and M.W. Brown. 2008. Reducing the risk of lethal encounters: Vessels and right whales in the Bay of Fundy and on the Scotian Shelf. Endangered Species Research 4:283-297.

Vennesland, R. G. 2000. The effects of disturbance from humans and predators on the breeding decisions and productivity of the Great Blue Heron in south-coastal British Columbia. M.Sc. thesis. Simon Fraser Univ., Burnaby, B.C.

Vos, D.K., P. A. Ryder, and W. D. Graul. 1985. Response of breeding great blue herons to human disturbance in Northcentral Colorado. Colonial Waterbirds 8:13–22.

Waldbusser, G. G. and J. E. Salisbury. 2014. Ocean acidification in the coastal zone from an organism's perspective: Multiple system parameters, frequency domains, and habitats. Annual Review of Marine Science 6:221-247.

Watling L. and E. A. Norse. 1998. Disturbance of the seabed by mobile fishing gear: a comparison to forest clearcutting. Conservation Biology 12:1180–1197.

Watling, L., R. H. Findlay, L. M. Mayer, and D. F. Schick. 2001. Impact of a scallop drag on the sediment chemistry, microbiota, and faunal assemblages of a shallow subtidal marine benthic community. Journal of Sea Research, 46(3):309-324.

Watts, B.D. and D.S. Bradshaw. 1994. The influence of human disturbance on the location of great blue heron colonies in the lower Chesapeake Bay. Colonial Waterbirds 17(2):184-186.

Weinberg, J. R. 2002. Influence of rising sea surface temperature on commercial bivalve species of the U.S. Atlantic coast. Fisheries in a Changing Climate 32:131-140.

Weinstein, J. E. 1996. Anthropogenic impacts on salt marshes – A review. In Sustainable Development in the Southeastern Coastal Zone. Edited by F. J. Vernberg, W. B.

Vernberg, and T. Siewicki. University of South Carolina Press, Columbia, SC. 1996. pp. 135-170.

White, M. M., D. C. McCorkle, L. S. Mullineaux, and A.L. Cohen. 2013. Early exposure of bay scallops (*Argopecten irradians*) to high CO_2 causes a decrease in larval shell growth. PLoS ONE 8:e61065.

White, M. M., L. S. Mullineaux, D. C. McCorkle, and A. L. Cohen. 2014. Elevated pCO_2 exposure during fertilization of the bay scallop *Argopecten irradians* reduces larval survival but not subsequent shell size. Marine Ecology Progress Series 498:173-186.

Whitman, A., A. Cutko, P. deMaynadier, S. Walker, B. Vickery, S. Stockwell, and R. Houston. 2013. Climate Change and Biodiversity in Maine: Vulnerability of Habitats and Priority Species. Manomet Center for Conservation Sciences (in collaboration with Maine Beginning with Habitat Climate Change Working Group) Report SEI-2013-03. 96pp.

Wildish D. J. and G. W. Pohle. 2005. Benthic macrofaunal changes resulting from finfishmariculture. In Environmental effects of marine finfish aquaculture. Handbook of Environmental Chemistry. Edited by E. Hargrave E and T. Barry. Springer Berlin, Heidelberg, pp 275–304.

Wilhelmsson D., T. Malm, amd M. C. Ohman. 2006. The influence of offshore wind power on demersal fish. ICES Journal of Marine Science 63:775-784.

Winn, B, et al. 2013. The Atlantic Flyway Shorebird Business Strategy. http://manometcenter.pairserver.com/sites/default/files/publications_and_tools/AtlanticFlywayShorebirdBusinessStrategy.pdf.

Worm B., E. B. Barbier, N. Beaumont, J. E. Duffy, C. Folke, B. S. Halpern, J. B. C. Jackson, H. K. Lotze, F. Micheli, S. R. Palumbi, E. Sala, K. A. Selkoe, J. J. Stachowicz, and R.Watson. 2006. Impacts of biodiversity loss on ocean ecosystem services. Science 314:787-790.

Wyatt, L. H., A. L. Baker, and D. L. Berlinsky. 2010. Effects of sedimentation and periphyton communities on embryonic Rainbow Smelt, Osmerus mordax. Aquatic Sciences 72(3):361-369.